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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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End-cap assembly for a filter

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The present invention relates to an end-cap assembly for a filter, in particular, to an end-cap assembly for a hollow fiber filter. The invention also relates to a filter comprising such an end-cap assembly.

A conventional hollow fiber filter comprises a tubular housing, a semi-permeable membrane in the form a bundle of hollow fibers extending within the housing and secured thereto at both ends, and two end-caps closing the housing at both ends. The ends of the fibers are secured to the housing by a potting compound in which they are embedded. The potting compound forms a disk that extends perpendicularly to the longitudinal axis of the housing. The ends of the fibers open on an outer surface of the disks of potting material. By construction, such a hollow fiber filter therefore comprises a first and the second compartments isolated from each other: the first compartment includes the interior of the hollow fibers and the space delimited at each end of the filter between the outer surface of the disk of potting compound and the inner surface of the end-cap, and the second compartment includes the space outside of the hollow fibers that is delimited by the inner surface of the housing and the inner surface of the disks of potting material. Each end-cap comprises an inlet/outlet nozzle through which a liquid can be flown into and out of the first compartment. The housing is also fitted with one or two nozzle that gives access to the second compartment.

Hollow fiber filters are used in particular in various extracorporeal treatments of blood, such as hemodialysis, hemofiltration, hemodiafiltration, plasmapheresis. The same type of filter, usually referred to as hemodialyzer or hemofilter, is used for hemodialysis, hemofiltration, hemodiafiltration. The main difference between a hemodialyzer and a plasmafilter (i.e. the filter used in plasmapheresis) is the pore size of their respective membrane, a membrane for plasmapheresis allowing the proteins contained in blood to migrate therethough, whereas a membrane for hemodialysis does not.

In all these treatments, blood is withdrawn from the patient, flown through the first compartment of a hollow fiber filter, and return to the patient. In hemodialysis, a dialysis liquid is simultaneously flown though the second compartment of the filter

and the metabolic wastes (urea, creatinine) contained in blood migrate by diffusion through the membrane into the second compartment. In hemofiltration, a pressure difference is created across the membrane so that plasma water flows through the membrane into the second compartment of the filter. Here, metabolic wastes migrate by convection into the second compartment. In order to compensate for the loss of bodily fluid, the patient is simultaneously injected a sterile substitution solution. Hemodiafiltration is a combination of hemodialysis and hemofiltration, and, in this treatment, a dialysis liquid is flown through the second compartment and a substitution liquid is injected to the patient. In plasmapheresis, a pressure difference is created across the membrane so that plasma (i.e. plasma water and proteins) flows through the membrane into the second compartment of the filter. Once treated, the plasma is returned to the patient.

A machine for performing any of the above treatments comprises a peristaltic pump for withdrawing blood from a patient through a so-called arterial line connected at one end to the vascular circuit of the patient and at the other end to the inlet nozzle of the first compartment of a filter, for pumping blood into the filter, and for returning blood to the patient through a so-called venous line connected at one end to the outlet nozzle of the first compartment of the filter and at the other end to the vascular circuit of the patient. The machine also usually comprises a first blood pressure sensor for measuring the pressure of blood in the arterial line upstream of the pump, a second blood pressure sensor for measuring the pressure of blood in the arterial line downstream of the pump, a third pressure sensor for measuring the pressure of blood in the venous line, a bubble detector for detecting air bubbles in the venous line and a clamp for closing the venous line, for example when air bubbles are detected by the bubble detector. An arterial line typically comprises the following components connected together by segments of flexible tubes: a first Luer connector for connection to an arterial cannula, an arterial bubble trap, a pump hose for cooperating with the rotor of the peristaltic pump of the machine, and a second Luer connector for connection to the inlet nozzle of the first compartment of the filter. A venous line typically comprises the following components connected together by segments of flexible tubes: a first Luer connector for connection to the outlet nozzle of the first compartment of the

filter, a venous bubble trap, and a second Luer connector for connection to a venous cannula. Usually, the first and third pressure sensors of the machine are connected to the arterial and venous bubble trap respectively, when the machine, the arterial line the venous line and the filter are assembled in view of a treatment.

A dialysis machine further comprises a dialysis liquid generator that can be connected through a supply line to the inlet nozzle of the second compartment of a hemodialyzer. The dialysis machine also comprises a waste line that can connect the outlet nozzle of the hemodialyzer to the drain. A hollow fiber ultrafilter of similar construction as described above can be connected to the supply line so that an extra pure dialysis liquid is supplied to the hemodialyzer. The invention also applies to such an ultrafilter.

The assemblage of the arterial and venous line to the filter and to the machine in preparation for a treatment is time consuming, and an object of the invention is to design and end-cap assembly that facilitates such assemblage.

According to the invention, an end-cap assembly for closing one end of a housing of a filter, comprises:

- an end-cap having an end wall;
- an inlet port extending through the end wall for connection to a first end of a pump hose of a peristaltic pump; and
- a first holder for securing a second end of the pump hose,

whereby the inlet port and the first holder are arranged relative to each other so that the pump hose forms a loop when the first end the pump hose is connected to the inlet port and the second end of the pump hose is secured by the holder.

Within the frame of the invention, "inlet port" means the passage through the end wall of the end-cap as well as any straight or bent nozzle or channel that may extend this passage on the outer side of the end cap.

This arrangement facilitates the loading of the filter in a machine having a peristaltic pump for circulating a liquid in the filter.

According to one variant of the invention, the inlet port and the first holder are arranged relative to each other so that the loop formed by the pump hose substantially extends in a plane that is tilted with respect to a plane perpendicular to a central axis of the end-cap. In particular, the inlet port and the first holder are arranged relative to each other so that the first end and second end of the pump hose are longitudinally spaced apart from each other with respect to the central axis of the end-cap and the second end of the pump hose is further apart from the end-cap than the first end of the pump hose.

When a hemodialyzer or a hemofilter comprising this end-cap assembly is hold in the usual operative position, i.e. vertical, with the end-cap assembly being at the lowest point, this arrangement helps degas the pump hose, in particular when a circuit including the filter is primed with a liquid (e.g. a sterile saline liquid) before the filter is used for treating blood.

According to another variant of the invention, the inlet port and the first holder are arranged relative to each other so that the loop formed by the pump hose substantially extends in a plane parallel to a central axis of the end-cap when the first end of the pump hose is connected to the inlet port and the second end of the pump hose is secured by the first holder.

According to one feature of the invention, in order to facilitate the packaging of a filter comprising the end-cap assembly, the first holder is removably mounted on the end-cap.

According to another feature of the invention, the end-cap assembly comprises a second holder for holding the pump hose between the inlet port and the first holder.

According to yet another feature of the invention, the end-cap assembly comprises a pump hose connected to the inlet port and the holder, e.g. by gluing or welding.

Other additional or alternative features of the invention are as follows:

- The first holder comprises a tubular connector for connecting the pump hose to a tube.

- The first holder comprises a clip for snugly engaging a tubular connector for connecting the pump hose to a tube. The tubular connector is removable and the clip is designed to resiliently engage and lock the tubular connector.

- The end-cap assembly comprises at least one infusion port connected to the inlet port and a pressure measurement port connected to the inlet port for measuring a pressure of liquid upstream of the pump hose.

- The end-cap assembly comprises at least one infusion port connected to the first holder and a pressure measurement port connected to the first holder for measuring a pressure of liquid downstream of the pump hose.

Another object of the invention is a pump hose having a first end and second end designed for connection to the inlet port and the holder of such an end-cap assembly.

Still another object of the invention is a filter comprising such an end-cap assembly.

Other features and advantages of the invention will appear on reading the detailed description that follows. Reference will be made to the appended drawings in which:

Figure 1 is a perspective view of a portion of a hollow fiber filter comprising an end-cap assembly according to the invention;

Figure 2 is perspective view of a second embodiment of an end-cap assembly according to the invention;

Figure 3 is a cross-section view of the end-cap assembly of Figure 2;

Figure 4 is a perspective view of the end-cap assembly shown in Figures 2 and 3 fitted with a pump hose;

Figure 5 is cross-section view of the end-cap assembly of Figures 2 to 4 mounted on an end of a hollow fiber filter;

Figure 6 is a perspective view of a third embodiment of an end-cap assembly according to the invention;

Figure 7 is a perspective view of a fourth embodiment of an end-cap assembly according to the invention;

Figure 8 is a perspective view of a fifth embodiment of an end-cap assembly according to the invention;

Figures 9a and 9b are perspective views of the two parts of the holder of the end-cap assembly of Figure 8;

Figures 10a and 10b are longitudinal cross section views of two embodiments of the tubular connector of the holder of the end-cap assembly of Figure 8;

Figures 11a and 11b are plan views of two arterial blood line designed to equip the end-cap assembly of Figure 8;

Figure 12 is a longitudinal cross section view of a sixth embodiment of an end-cap assembly according to the invention.

Figure 1 shows an end-cap assembly 1 mounted at one end of a tubular housing 2 of a filter. The end-cap assembly 1 comprises an end-cap 3 having a slightly cambered circular end wall connected to a cylindrical peripheral wall by which the

end-cap 3 is secured to the housing 2 of the filter. When the end-cap 3 is mounted on the housing 2 of a filter, as shown, the circular end wall of the end-cap 3 is substantially perpendicular to the longitudinal axis of the housing 2, and the central axis 9 of the end-cap 3 coincides with the longitudinal axis of the housing 2. The end-cap assembly 1 further comprises a nozzle 8 made integral with the end-cap 3 so as to form an inlet port and give access to the interior of the end-cap 3, and a tubular holder 5, which is secured to the nozzle 8 so as to be further apart from the end-cap 3 than the nozzle 8. The tubular holder 5 can be welded or glued to or formed integral with the nozzle 8. The tubular holder 5 has a larger section at one end for connection to a pump hose 4 and a smaller section at the other end for connection to a tube 7. The inlet port 8 and the tubular holder 5 are oriented with respect to each other so that when a first end 4a of a pump hose 4 is connected to the inlet port 8 and the second end 4b of the pump hose 4 is connected to the tubular holder 5, the pump hose 4 forms a loop. It results from the relative position of the inlet port 8 and of the holder 5 that the first end 4a of pump hose 4 is offset from the second end 4b along the central axis 9 of the end-cap 3. Also connected to the holder 5 is a tube 7 which may be a portion of the arterial blood line of an extracorporeal blood treatment system.

The loop portion of the pump hose 4 is capable of readily cooperating with a peristaltic pump of the rotary type upon connection of the filter to a treatment device (e.g. a dialysis machine). A rotary peristaltic pump comprises a rotor generally bearing two rollers at its periphery. The rotor is surrounded by a semicircular wall set apart from the rotor by a distance sufficient to receive the pump hose 4. The rollers engage the pump hose 4 and pinch the hose by acting on the hose against the semicircular wall. At the same time, the rotor moves the rollers in engagement with the pump hose along the section of hose between the rotor and the wall, thereby urging fluid forward through the tube. The action of engaging the pump hose with the peristaltic pump therefore requires the pump hose to be inserted between the rotor and the semicircular wall.

Although the looped pump hose 4 lies substantially in a plane perpendicular to the central axis 9, it also possesses a slight degree of inclination in order to assist the

progress of air or gas bubbles through the hose into the filter and to avoid stagnation of gas bubbles. The desired angle of inclination of the looped hose 4 to a plane perpendicular to the central axis 9 may lie within the range of 3 to 7 degrees, more preferably 5 degrees.

The end-cap assembly 1 comprises two Infusion/injection ports 6a, 6b connected to the tubular holder 5, which can be used for the injection of various substances (e.g. heparin or a substitution solution) to the liquid (e.g. blood) flowing through the filter. One of theses ports can also be used as a pressure measurement port for connection to a pressure sensor capable of measuring the pressure of the liquid upstream of the pump hose 4. The end-cap assembly 1 also comprises a pressure measurement port 10 connected to the inlet port 8 for connection to a pressure sensor capable of measuring the pressure of the liquid entering the first compartment of the filter.

Figures 2 to 4 show a second embodiment of the end-cap assembly 1 of the invention. On Figures 2 and 3, the end-cap assembly 1 is represented without a pump hose connected thereto, whereas in Figures 4 and 5 a pump hose 4 is connected to the inlet port 8 and to the holder 5, 23. The end-cap 3 comprises a circular end-wall portion 14 connected to a peripheral wall portion 12 that is designed for securing the end-cap 3 to the housing of a filter. The end-cap 3 has a central axis 9 that coincides with the longitudinal axis of the tubular housing of a filter when the end-cap is mounted at one end of such a housing. The circular end wall portion 14 and the peripheral wall portion 12 define an interior region 15 of the end-cap 3. The interior region 15 forms part of a header-chamber when the end-cap is in place on a filter (see Figure 5). An inlet port 8 eccentric with regard to the central axis 9 is formed integral with the end-wall 14 and of the end-cap 3. The inlet port 8 has a curved profile such that a liquid flowing through a pump hose at an angle perpendicular to the central axis 9 is channeled into a direction towards the interior region 15 of the end-cap 3 generally parallel to the central axis 9. The inlet port 8 has a first portion 18, cylindrical, that extends at an angle generally perpendicular to the central axis 9, and a second portion 19 that flares into the interior 15 of the end-cap 3 along an axis generally parallel to the central axis 9.

The first and second portions 18 and 19 of the inlet 8 are connected by an intermediate portion 20 having a radius 16. The inlet port 8 also comprises a base portion 21, having a radius 17, by which it is attached to the end wall 14. The radius 16 of the intermediate portion 20 and the radius 17 of the base portion 21 may have an equal magnitude. A suitable value for both radii lies in the range of about 6 to 12 mm, preferably about 9 mm. This disposition helps to ensure a smooth passage and distribution of fluid through the inlet port 8 and into the interior region 15.

The first portion 18 of the fluid inlet port 8 is oriented at a slight angle to a plane perpendicular to the central axis 9, as can be seen in Figure 3. This allows for the inclined position in which the pump tube 4 is to be held. The angle of inclination can be in the range of 3 to 7 degrees, preferably 5 degrees.

The end-cap assembly further comprises a first holder for the pump hose 4 comprising a leg 23 protruding at the periphery of the end-cap 3 and a tubular connector 5 attached to the leg 23 so that the longitudinal axis of the tubular connector 5 is substantially parallel to a line tangential to the circular end wall portion 14 of the end-cap 3. It results from this construction that the inlet port 8 and the tubular connector 5 are spaced apart with respect to the central axis 9, both axially and longitudinally, the inlet port 8 being closer to the end-cap 3 than the connector 5. The distance between the tubular connector 5 and the circular end-cap wall 14 is selected such that a desired inclination of the pump tube segment 4 is maintained. The first holder 5, 23 may be formed integral with the end-cap 3, or it may be fixed to the end-cap 3 for example by bonding or by welding. The tubular connector 5 comprises a first socket of larger section at one end for connection to the pump hose 4 and a second socket 27 of a smaller section at the other end for connection to a tube (e.g. an arterial blood line). The socket 27 can comprise a Luer connection element (not shown) for attachment to a tube fitted with a complementary Luer connection element. The connector 5 also comprises two ports 6a, 6b that can be used for infusing a liquid into the filter or to measure the pressure in the liquid upstream of a peristaltic pump.

The end-cap assembly represented In Figures 2 to 5 further comprises a second holder 22 for the pump hose 4 comprising an arm extending outside from the periphery of the end-cap 3, substantially opposite the first holder 5, 23 with respect to the inlet port 8. The second holder 22 comprises a grip at its outer end for receiving and holding a portion of the pump tube 4. The provision of the second holder 22 helps to give rigidity to the pump tube 4 and thereby improves the positioning of the pump tube segment 4 around the rotor of a peristaltic pump of a monitoring device. The second holder 22 can be formed integral with the end-cap 3, or it can be attached to the end-cap by e.g. bonding or welding.

In Figure 4, a U-shaped pump hose 4 is shown connected to the inlet port 8 and the first holder 5, 23 of the end-cap assembly 1. The pump hose 4 is also supported by the second holder 22 whose curved end portion partially surrounds the pump hose 4. The U-shaped hose includes a portion having a bend at the point of support by the second holder 22. This is provided in order to maintain the straight sided U-shape of the pump hose such that it may easily fit over the rotor of a peristaltic pump (not shown) upon connection to a monitoring device, while at the same time allowing the tube to be connected to the inlet port 8 disposed on the end wall 14. The first end 4a of the pump hose 4 is thereby aligned with the first portion 18 of the inlet port 8.

Figure 5 shows the end-cap assembly 1 of Figures 2 to 4 connected to the housing 2 of a hollow fiber filter. A liquid, represented by arrows, flows through the pump hose 4 and enters via the inlet port 8 into the header chamber 15 of the filter, which is delimited by the interior surface of the end-cap 3 and the outer surface of a disk of potting compound 26 in which one end of a bundle of hollow fibers 25 is embedded.

Figure 6 shows a third embodiment of the end-cap assembly according to the invention. The first holder 5, 23 of this end-cap assembly is removable. The end-cap 3 comprises a fixation element in the form of two parallel grooves 13, and the leg 23 of the holder comprises a complementary fixation element in the form of two parallel tongues designed to snugly fit in the grooves 13 when they are engaged

therein. The tubular connector 5 comprises three ports 6a, 6b, 6c opening opposite the end-cap 3, which can be used for injecting or infusing various liquids (e.g. heparin and a substitution solution) and for connection to a pressure sensor. In this embodiment, the second holder 22 is connected to the inlet port 8 and it comprises a curved portion that leads to a tubular clip 24 forming the outer end of the holder. The clip 24 is resilient and can be opened so as to receive a portion of a pump hose that it snugly holds when closed. The curved portion of the second holder 22 forms a partial cradle for a portion of pump hose when a pump hose is connected to the inlet port 8 ant to the tubular connector 5, while passing through the clip 24. Here also it can be noted that the respective dimension and orientation of the inlet port 6 and the connector 5 are such that they are spaced apart axially and longitudinally with respect to the central axis of the end-cap 3, and that a pump hose connected thereto would form a loop slightly tilted with respect to a plane perpendicular to this central axis.

Figure 7 shows a fourth embodiment of the end-cap assembly according to the invention. In this embodiment, the end-cap 3 comprises a tubular skirt to which an end portion of the inlet port 8 and of an end portion the holder 5 are connected so as to lie in a plane substantially perpendicular to the longitudinal axis of the filter. A pump hose 4 is connected to the inlet port 8 and to the connector 5 and forms a loop that extends in the same plane.

Figures 8 to 11b show a fifth embodiment of the end-cap assembly 1 according to the invention. In this embodiment, the holder does not comprise a tubular connector as in the embodiments of Figures 2 to 6, but instead its leg 23 is connected to and made integral with a resilient clip 50 having a C-shaped socket 51. The clip 50 has a longitudinal slit-like mouth 52 for allowing the engagement of a tubular connector 53 into the socket 51. The connector 53 has an outside diameter corresponding to the diameter of the C-shaped socket 51 and it comprises two circular end flanges 54 for preventing the connector 53 from longitudinally moving in the socket 51 when the connector 53 is engaged in the clip 50.

The tubular connector 53 is connected to the second end 4b of a pump hose 4, the first end 4a of which is either permanently connected to the inlet port 8 of the end-cap 3 or comprises a connecting element 4c, for example of the Luer type, for connection to a complementary connecting element included in the outlet port 8.

The tubular connector 53 can also be pre-connected to a tube 7, as shown in Figures 10a and 11a, which represent an arterial blood line in which the tube 7 used for supplying blood from a patient to a hemodialyzer has a smaller diameter than the diameter of the pump hose 4. In such a case, the inner bore of the connector 53 comprises a first end portion with a smaller diameter corresponding to the outer diameter of the tube 7, a second end portion with a larger diameter corresponding to the outer diameter of the pump hose 4 and an intermediary portion flaring from the first end portion to the second end portion. The arterial blood line comprises a connecting element at both ends, one of which is the connector element 4c adapted to the inlet port 8, the other connector element being designed for connection to a cannula.

When an arterial blood line comprises a pump hose 4 and a supply tube 7 having the same diameter, the internal bore of the connector 53 is cylindrical and corresponds to the outer diameter of the pump hose 4 and the tube 7 that can be made of the same piece of tubing (see Figures 10b and 11b). In this case, the connector 53 is merely slipped on the piece of tubing before being glued thereto at the appropriate location.

Figure 12 shows a sixth embodiment of the end-cap assembly 1 according to the invention. This end-cap assembly substantially differs from the previously described embodiments in that it is designed to hold a pump hose 4 in a plane containing the central axis of the end-cap 3.

In more details, Figure 12 represents an end portion of a filter having a tubular housing 2 containing a bundle of hollow fibers 25 secured to the housing 2 at the end thereof by a disk of potting material 26 in which the end of the fibers 25 are embedded. The housing 2 is closed by an end-cap 3 having a circular end wall

whose central axis 9 coincides with the longitudinal axis 9 of the housing 2. A pump hose support 30 in the form of an elongated rectangular parallelepiped is connected to the end-cap 3 so that the longitudinal axis of the support 30 coincides with the central axis 9 of the end-cap 3. The pump hose support 30 comprises two separate parts 31 and 32 that can be connected together by a mechanical coupling (not shown).

The first part 31 of the pump hose support 30, which can be made integral with the end-cap 3, comprises a pressure measurement chamber 33 having a first and a second compartments separated by a flexible membrane 34 that lies in the plane of the figure. The first compartment of the pressure chamber 33 communicates with the end-cap 3 through a first portion 8a of an inlet port that extends along the central axis 9 of the end-cap 3. The first compartment of the pressure chamber 33 is also connected to the first end 4a of a pump hose 4 through a second portion 8b of the inlet port, whose longitudinal axis is perpendicular to the longitudinal axis 9 of the support 30. The first compartment can also be connected to a source of liquid (e.g. an infusion liquid) through a port 6 opposite to the second portion 8b of the inlet port. The second compartment of the pressure measurement chamber comprises an aperture 10 for the connection to a pressure sensor for the measurement of the pressure of the liquid downstream of the pump hose 4.

The second part 32 of the pump hose support 30 also comprises a pressure measurement chamber 37 having a first and a second compartments separated by a flexible membrane 38 that lies in the plane of the figure. The first compartment of the pressure chamber 37 is connected to a supply tube 7 through a channel 39 that extends along the longitudinal axis of the pump hose support 30. The first compartment of the pressure measurement chamber 37 is also connected to the second end 4b of the pump hose 4 through a channel 40, whose longitudinal axis is perpendicular to the longitudinal axis of the support 30. The first compartment can be connected to a source of liquid by a port 6 opposite to the channel 39. The second compartment of the pressure measurement chamber 37 comprises an aperture 10 for the connection to a pressure sensor for the measurement of the pressure of the liquid upstream of the pump hose 4.

Claims

1. End-cap assembly (1) for closing one end of a housing (2) of a filter, comprising:
- an end-cap (3) having an end wall (14);
- an inlet port (8; 8a,8b) extending through the end wall (14) for connection to a first end (4a) of a pump hose (4) of a peristaltic pump; and
- a first holder (5; 5,23; 50,23; 32) for securing a second end (4b) of the pump hose (4),

whereby the inlet port (8) and the first holder (5; 5,23; 50,23; 32) are arranged relative to each other so that the pump hose (4) forms a loop when the first end (4a) the pump hose (4) is connected to the inlet port (8) and the second end (4b) of the pump hose (4) is secured by the holder (5; 5,23; 50,23; 32).

2. End-cap assembly (1) according to claim 1, wherein the inlet port (8) and the first holder (5; 5,23; 50,23) are arranged relative to each other so that the loop formed by the pump hose (4) substantially extends in a plane that is tilted with respect to a plane perpendicular to a central axis (9) of the end-cap (3).

3. End-cap assembly (1) according to one of the claims 1 and 2, wherein the inlet port (8; 8a,8b) and the first holder (5; 5,23; 50,23; 32) are arranged relative to each other so that the first end (4a) and second end (4b) of the pump hose (4) are longitudinally spaced apart from each other with respect to the central axis (9) of the end-cap (3) when the first end (4a) of the pump hose (4) is connected to the inlet port (8; 8a,8b) and the second end (4b) of the pump hose (4) is secured by the first holder (5; 5,23; 50,23; 32).

4. End-cap assembly (1) according to claim 3, wherein the inlet port (8; 8a,8b) and the holder (5; 5,23; 50,23; 32) are arranged relative to each other so that the second end (4b) of the pump hose (4) is further apart from the end-cap (3) than the first end (4a) of the pump hose (4) when the first end (4a) of the pump hose (4) is connected to the inlet port (8; 8a,8b) and the second end (4b) of the pump hose (4) is secured by the first holder (5; 5,23; 50,23; 32).

5. End-cap assembly (1) according to one of the claims 1 to 5, wherein the inlet port (8; 8a,8b) and the holder (5; 32) are arranged relative to each other so that the first end (4a) and second end (4b) of the pump hose (4) are adjacent to the central axis (9) of the end-cap (3) when the first end (4a) of the pump hose (4) is connected to the inlet port (8; 8a,8b) and the second end (4b) of the pump hose (4) is secured by the first holder (5; 32).

6. End-cap assembly (1) according to one of the claims 1 to 5, wherein the inlet port (8) and the holder (5; 5,23; 50,23) are arranged relative to each other so that the first end (4a) and second end (4b) of the pump hose (4) are radially spaced apart from each other with respect to the central axis (9) of the end-cap (3) when the first end (4a) of the pump hose (4) is connected to the inlet port (8) and the second end (4b) of the pump hose (4) is secured by the first holder (5; 5,23; 50,23).

7. End-cap assembly (1) according to one of the claims 1 to 6, wherein the first holder (5; 5,23) comprises a tubular connector (5) for connecting the pump hose (4) to a tube (7).

8. End-cap assembly (1) according to one of the claims 1 to 6, wherein the first holder (50, 23) comprises a clip (50) for snugly engaging a tubular connector (53) for connecting the pump hose (4) to a tube (7).

9. End-cap assembly (1) according to claim 8, wherein the tubular connector (53) is removable and the clip (50) is designed to resiliently engage and lock the tubular connector (53).

10. End-cap assembly (1) according to one of the claims 1 to 9, wherein the first holder (5,23; 50,23) comprises a leg (23) protruding at a periphery of the end wall (14) of the end-cap (3) for holding the second end (4b) of the pump hose (4) longitudinally and radially spaced apart from the central axis (9) of the end-cap (3).

11. End-cap assembly (1) according to one of the claims 1 to 10, further comprising a second holder (22) for holding the pump hose (4) between the inlet port (8) and the first holder (5).

12. End-cap assembly (1) according to claim 11, wherein the second holder (22) comprises an arm protruding at a periphery of the end wall (14) of the end-cap (3) for holding the pump hose (4) radially spaced apart from the central axis (9) of the end-cap (3).

13. End-cap assembly (1) according to claim 1, wherein the inlet port (8a,8b) and the first holder (32) are arranged relative to each other so that the loop formed by the pump hose (4) substantially extends in a plane parallel to a central axis (9) of the end-cap (3) when the first end (4a) of the pump hose (4) is connected to the inlet port (8a,8b) and the second end (4b) of the pump hose (4) is secured by the first holder (32).

14. End-cap assembly (1) according to one of the claims 1 to 13, wherein the first holder (5,23; 32) is removably mounted on the end-cap (3).

15. End-cap assembly (1) according to one of the claims 1 to 14, further comprising at least one infusion port (6) connected to the inlet port (8a,8b).

16. End-cap assembly (1) according to one of the claims 1 to 15, further comprising a pressure measurement port (10) connected to the inlet port (8; 8a,8b) for measuring a pressure of liquid upstream of the pump hose (4).

17. End-cap assembly (1) according to one of the claims 1 to 16, further comprising at least one infusion port (6a,6b,6c) connected to the first holder (5; 5,23; 32).

18. End-cap assembly (1) according one of the claims 1 to 17, further comprising a pressure measurement port (10) connected to the first holder (5, 32) for measuring a pressure of liquid downstream of the pump hose (4).

19. End-cap assembly (1) according to one of the claims 1 to 18, further comprising a pump hose (4) connected to the inlet port (8; 8a,8b) and the holder (5; 5,23; 50,23; 32).

20. Pump hose (4) having a first end (4a) and second end (4b) designed for connection to the inlet port (8; 8a,8b) and the holder (5; 5,23; 50,23; 32) of the end-cap assembly (1) of one of the claims 1 to 18.

21. Filter comprising an end-cap assembly according to one of the claims 1 to 19.

22. Filter according to claim 21, comprising a semi-permeable membrane adapted to hemodialysis and hemofiltration.

Abstract

An end-cap assembly (1) for closing one end of a housing (2) of a filter comprises:

- an end-cap (3) having an end wall;
- an inlet port (8) extending through the end wall for connection to a first end (4a) of a pump hose (4) of a peristaltic pump; and
- a first holder (5) for securing a second end (4b) of the pump hose (4),

whereby the inlet port (8) and the first holder (5) are arranged relative to each other so that the pump hose (4) forms a loop when the first end (4a) the pump hose (4) is connected to the inlet port (8) and the second end (4b) of the pump hose (4) is secured by the holder (5).

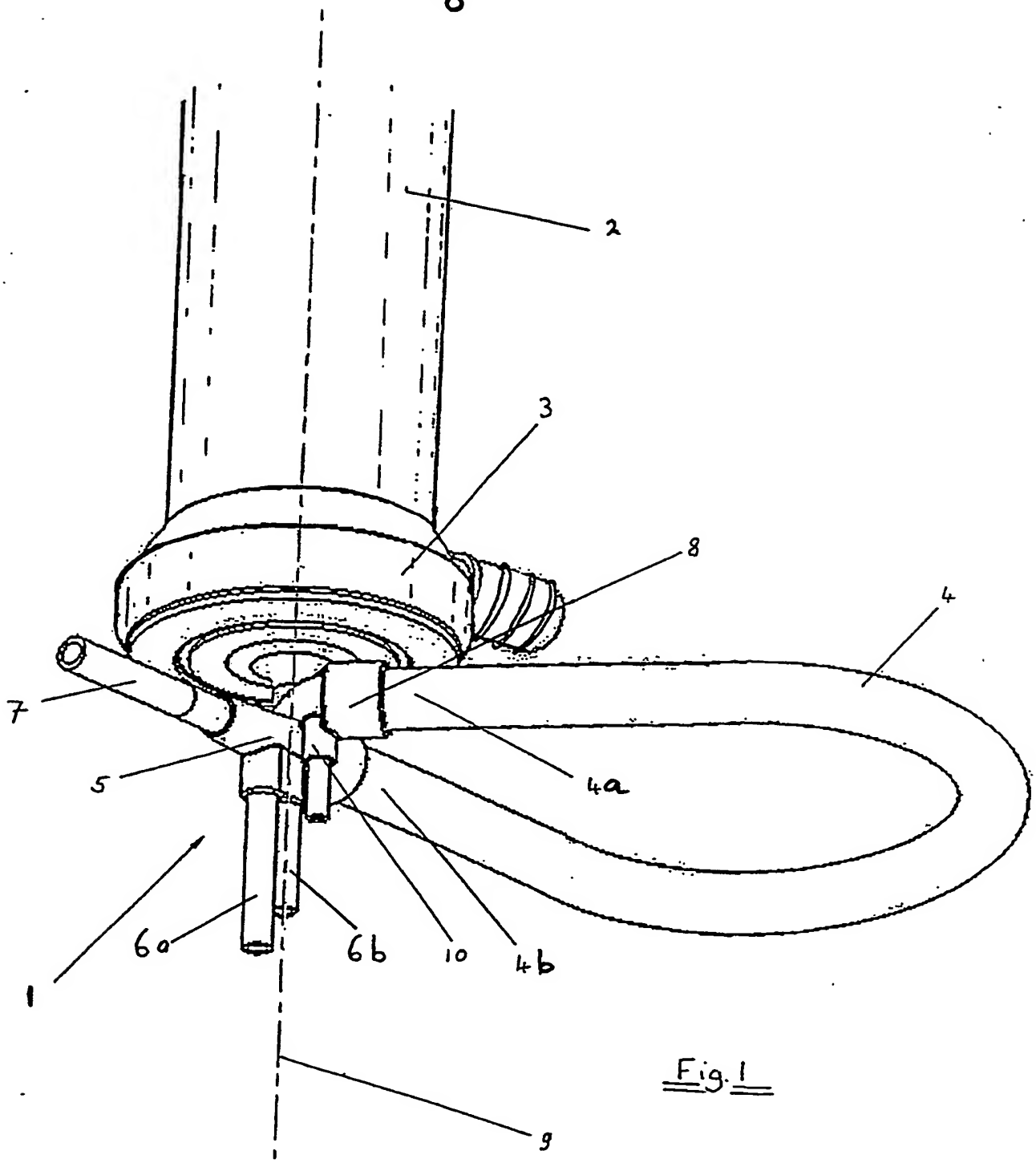


Fig. 1

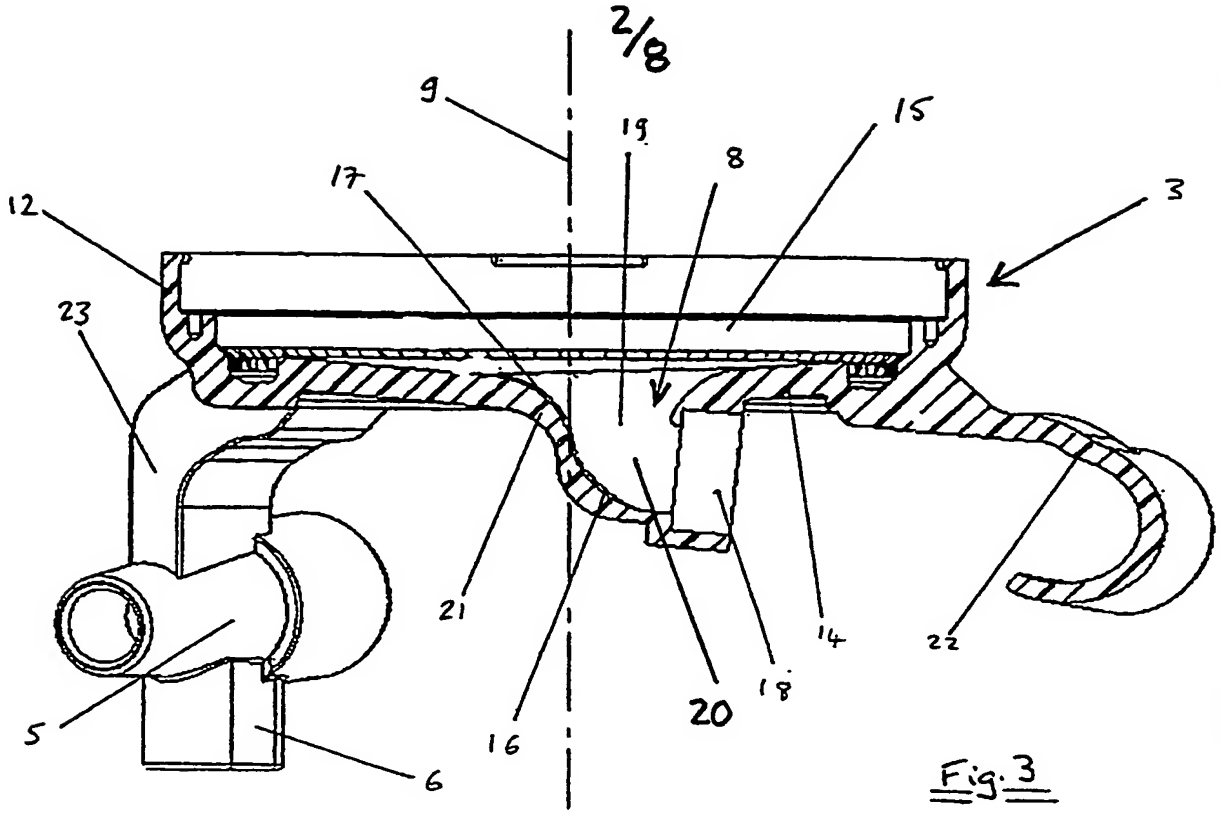


Fig. 3

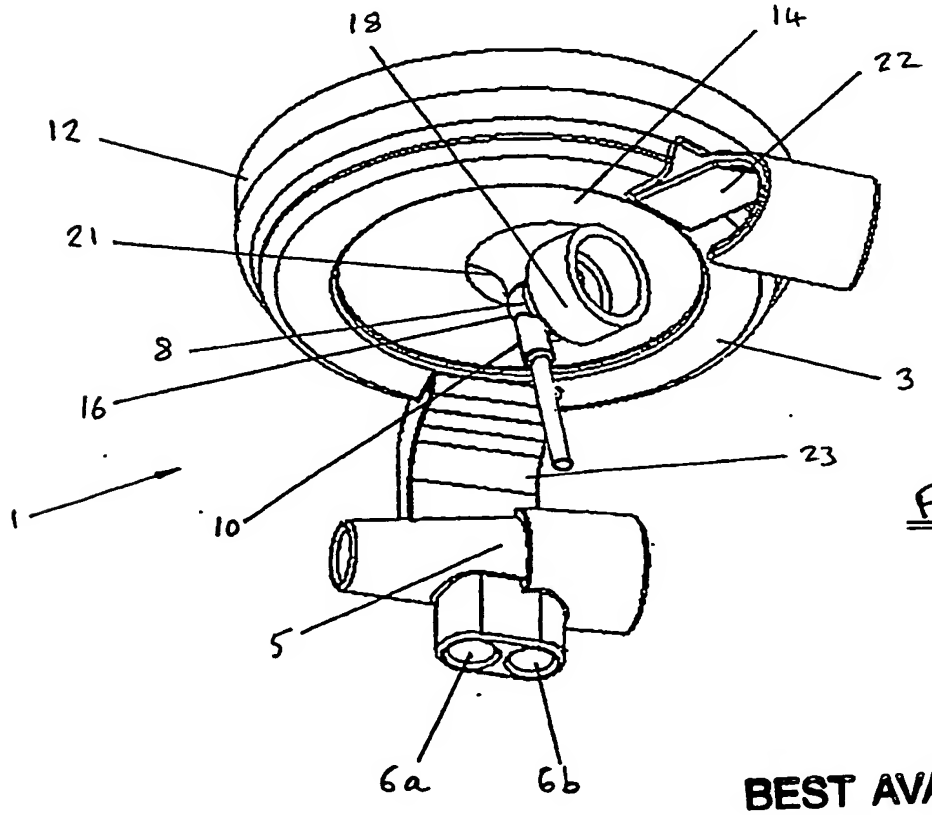


Fig. 2

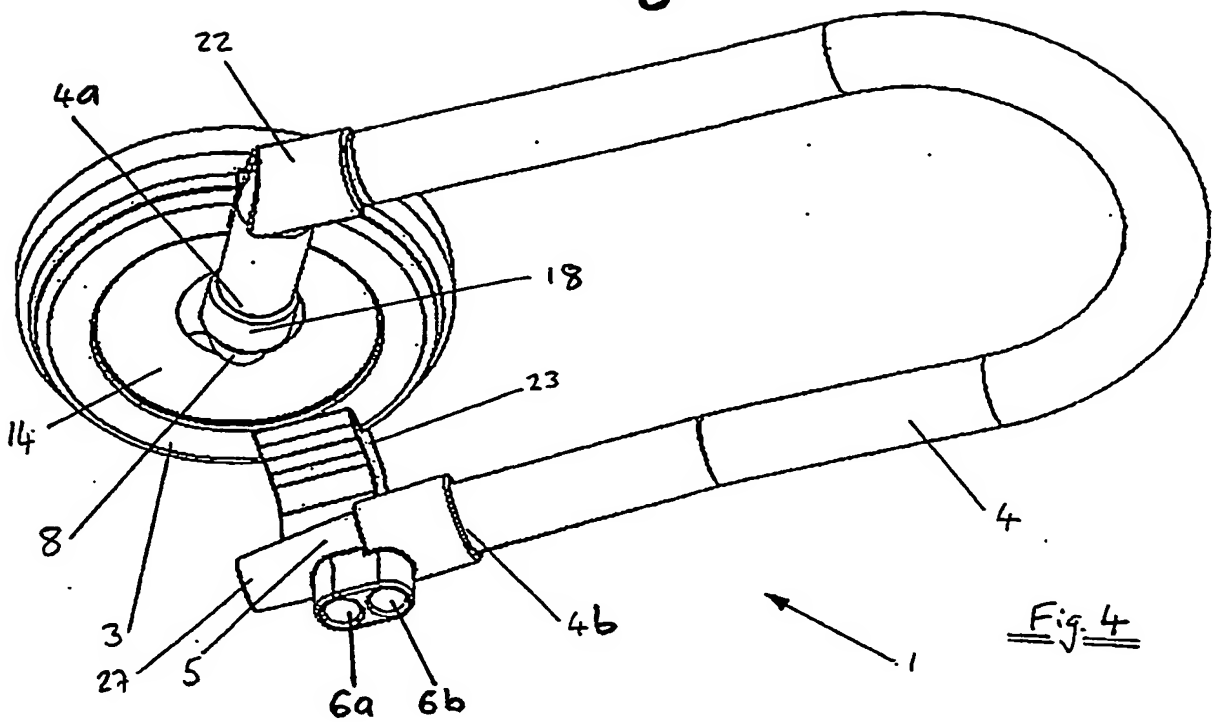


Fig. 4

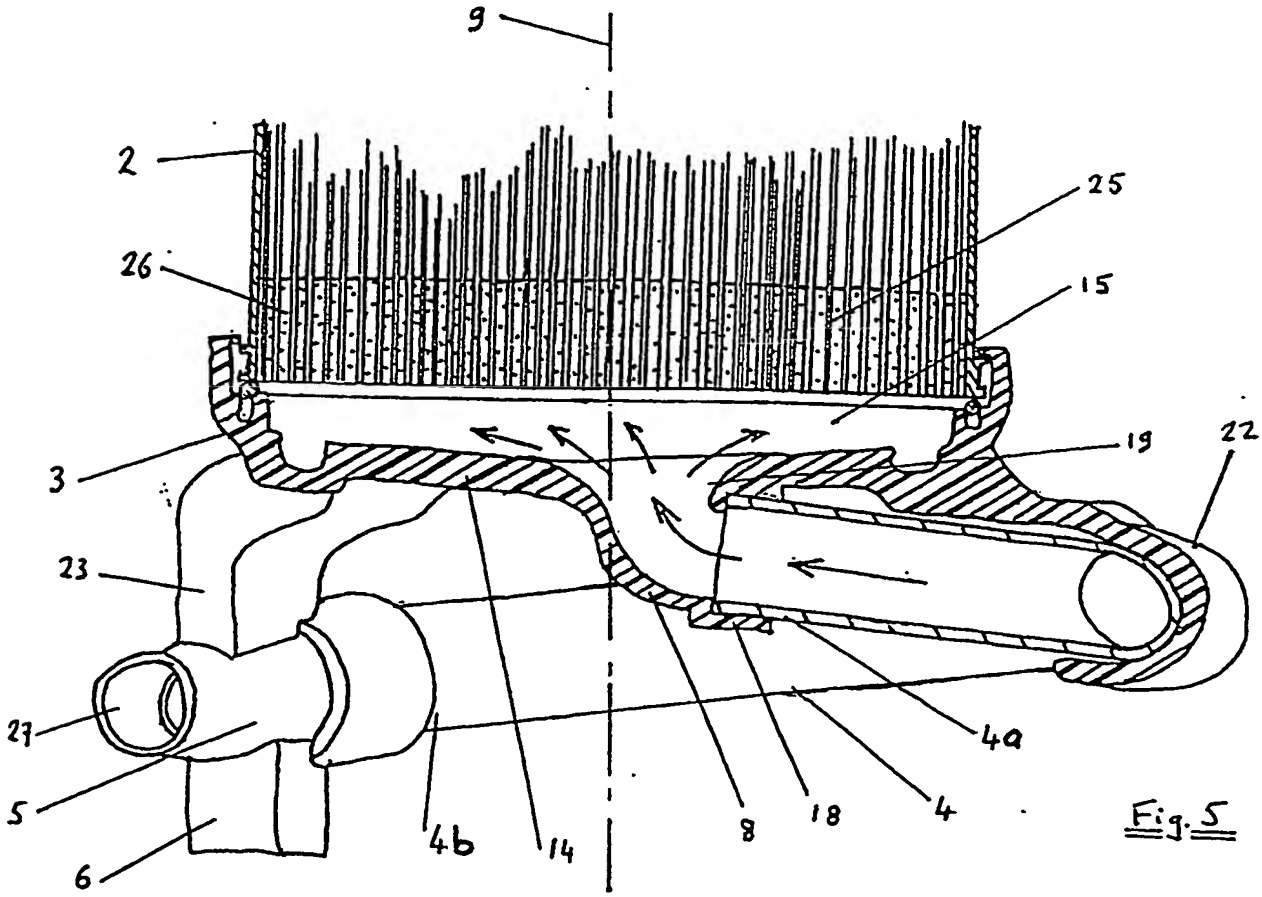


Fig. 5

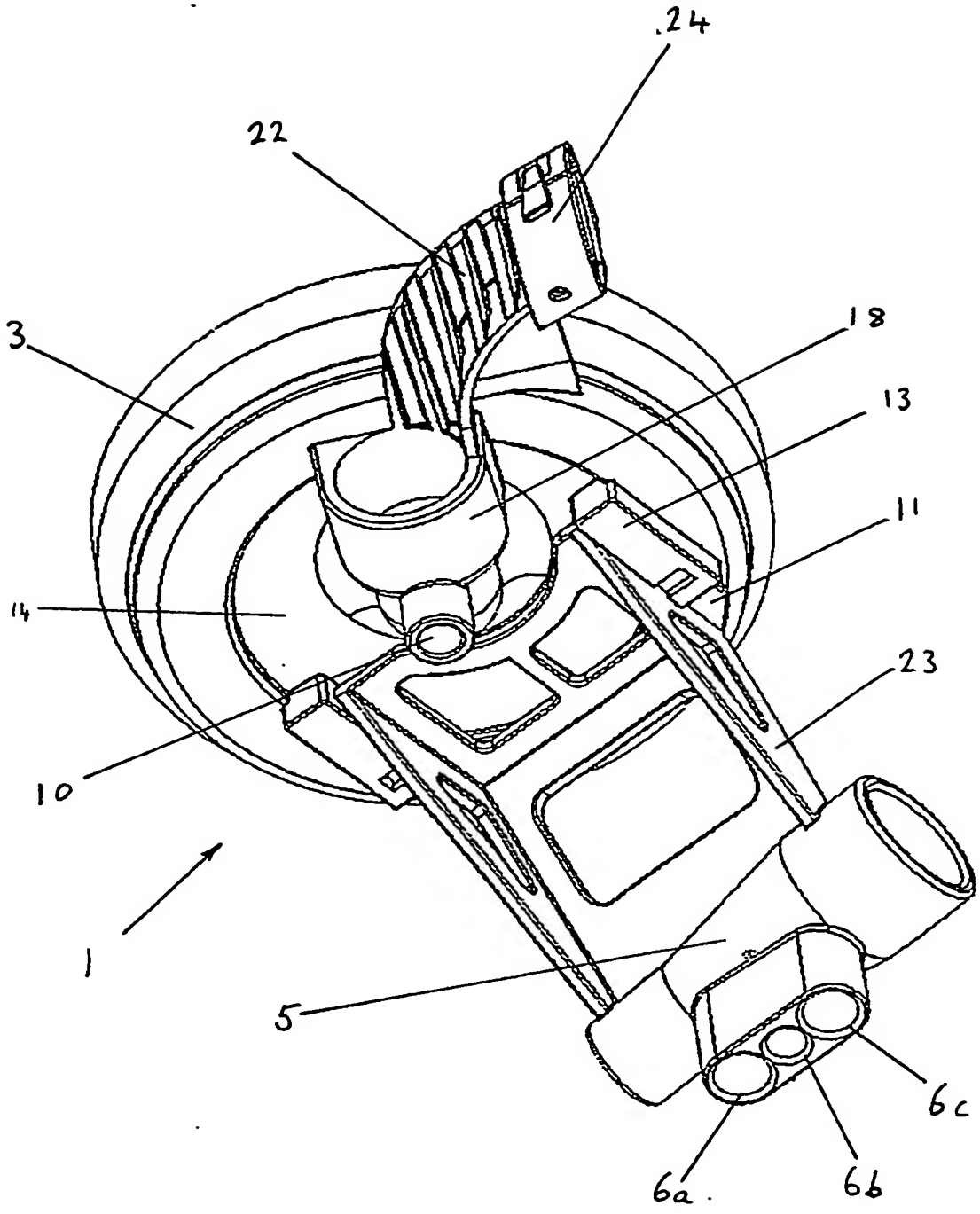


Fig 6

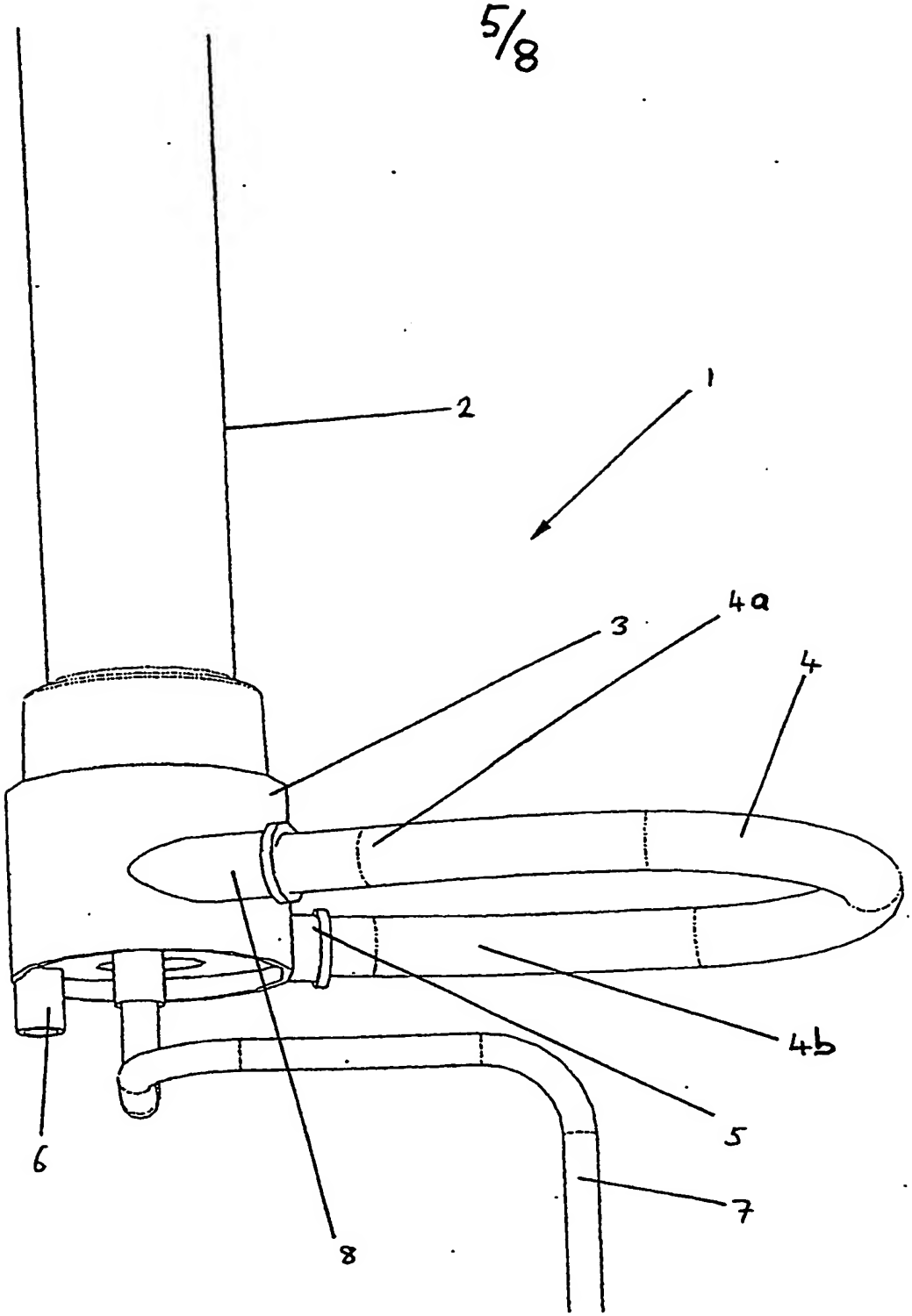


Fig 7

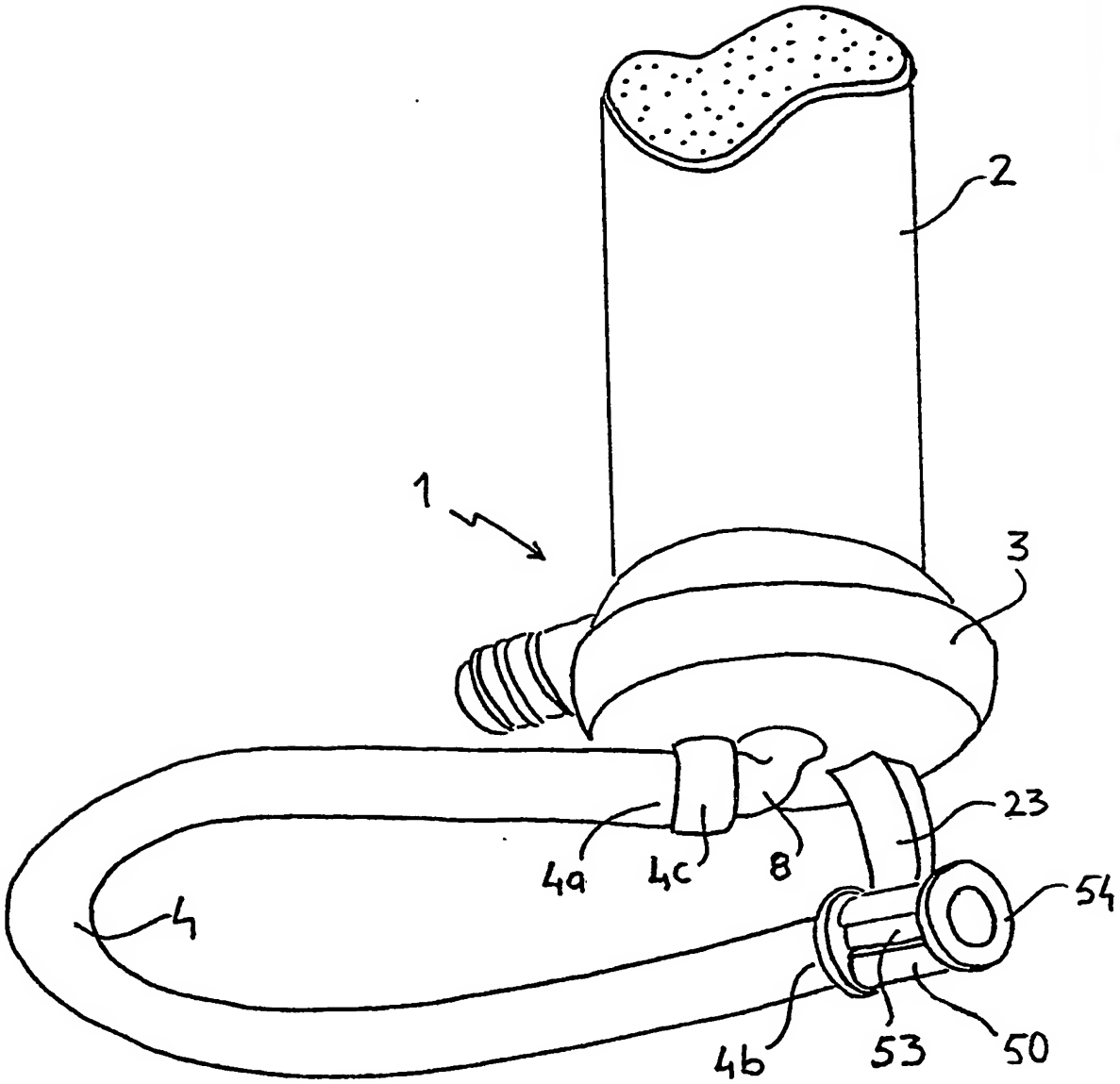


Fig 8

Fig 9a

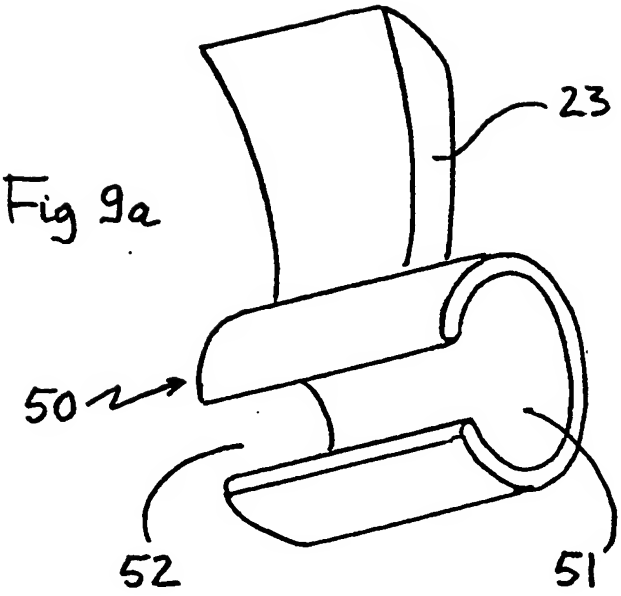


Fig 9b

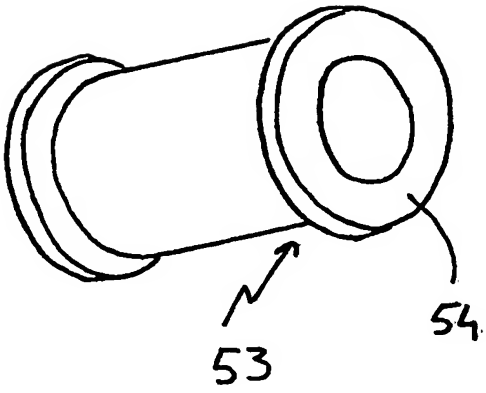


Fig 10a

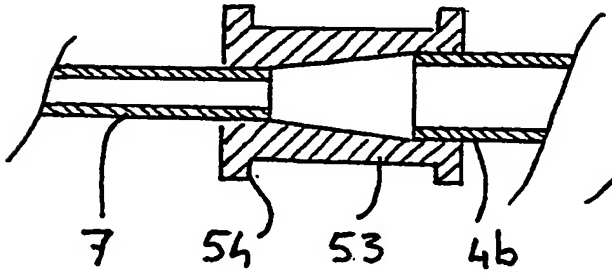


Fig 10b

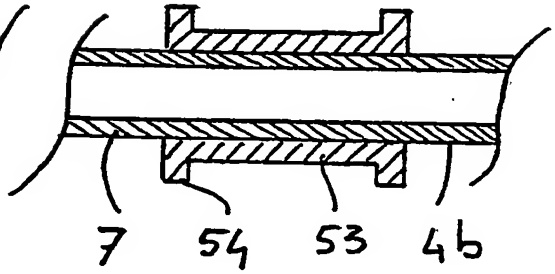


Fig 11a

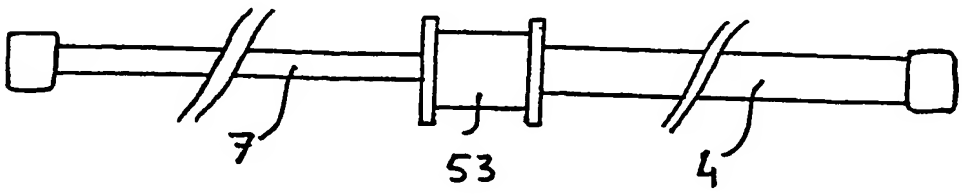
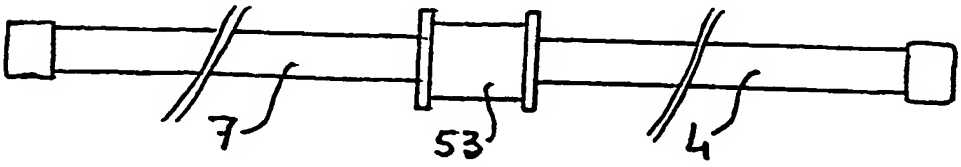


Fig 11b



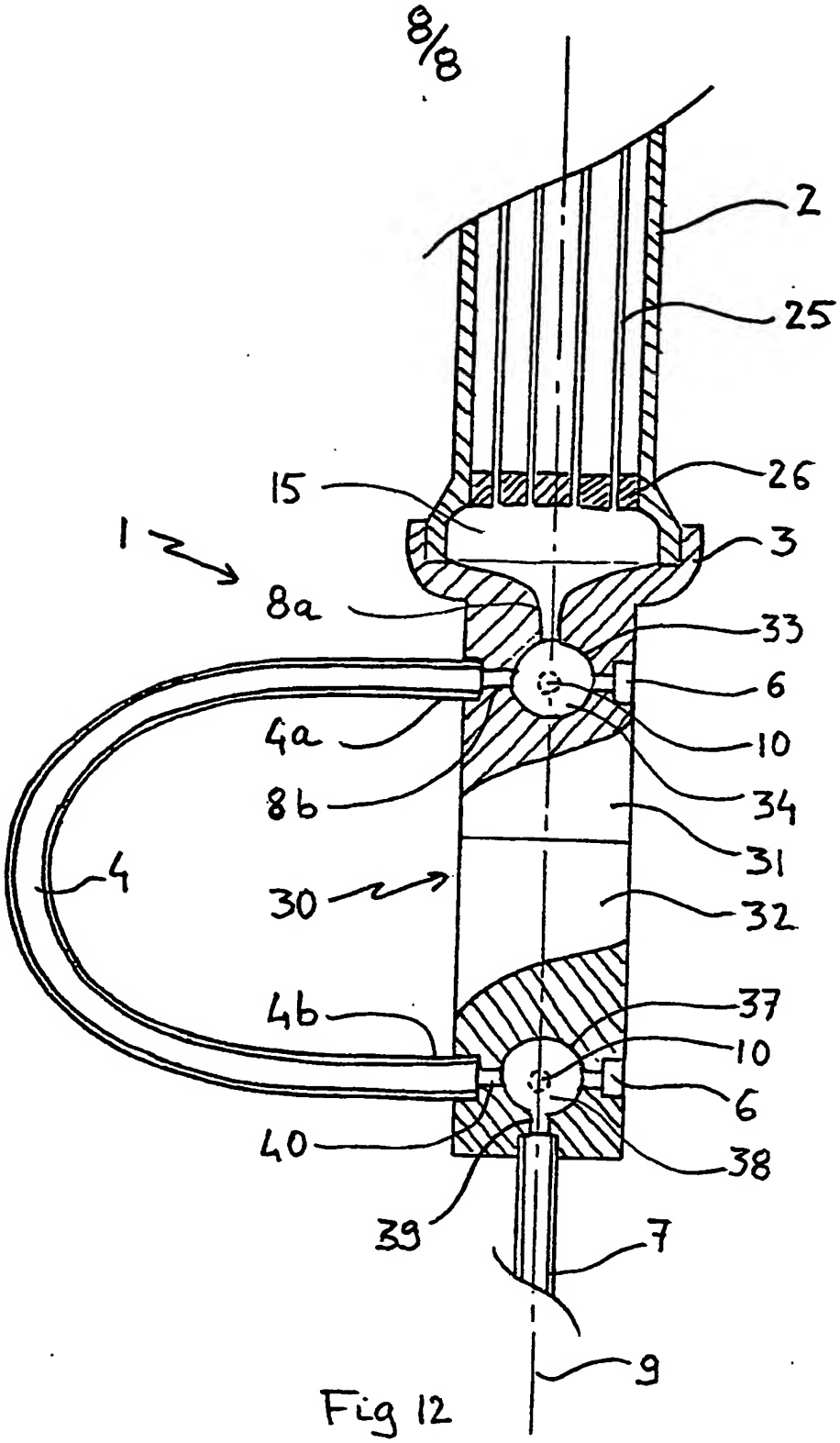


Fig 12